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Late Cretaceous carbon cycle changes – insights from a new Coniacian – Maastrichtian δ^{13}C curve of the boreal chalk succession at Lägerdorf–Kronsmoor (N-Germany)

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The Late Cretaceous was a period of long-term climate cooling succeeding the extreme warmth of the mid-Cretaceous greenhouse. Only little is known to date whether this cooling was continuously or a stepwise succession of distinct events. A main reason lies in the low temporal resolution of biostratigraphic zonations, especially during Campanian-Maastrichtian times. Carbon isotope stratigraphy can overcome these problems and is useful for long-range correlation. A new high-resolution carbon isotope curve from the Coniacian – Maastrichtian boreal chalk succession at Lägerdorf–Kronsmoor, N-Germany shows for the first time a continuous 20 million year long record of δ^{13}C changes in the inorganic carbon reservoir.

The Lägerdorf–Kronsmoor section consists of 420m of chalk deposited with an average sedimentation rate of 2.2cm/kyr on a tectonically stable intra-shelf platform. Available biostratigraphic data comprise zonations with boreal macrofossils, benthic foraminifera and calcareous nannofossils. The new carbon isotope curve was measured with a time resolution of 50 kyr for the middle Coniacian to early Maastrichtian and of 1 kyr for the late Campanian. Generally, the Campanian-Maastrichtian δ^{13}C record shows only little variability, a feature that differs distinctly from the large carbon isotope excursions in the Early and early Late Cretaceous. The most prominent signals are three negative excursions with magnitudes of 1-1.5 $\permil$ in the late Campanian, in the latest Campanian to earliest Maastrichtian, and in the late Maastrichtian. Beside these events, distinct small-scale δ^{13}C changes occur and can be correlated to

two other boreal chalk successions, the Santonian-Campanian Trunch borehole, UK (Jarvis et al. 2002) and the lower Upper Campanian succession at Lehrte, Germany (Niebuhr 2005). Results of spectral analysis on carbonate values and the δ^{13}C record allow the identification of long eccentricity cycles and the development of a floating 405 kyr time scale for the Santonian-Campanian. Based on this time scale and the high-resolution δ^{13}C correlation, first occurrence ages of calcareous nannofossils in the boreal chalk sea are significantly diachronous with magnitudes of up to 1.5 million years.

The three negative carbon isotope excursions last about 1 million years and are associated with major regressions on epicontinental shelves. The latest Campanian to earliest Maastrichtian carbon isotope event is also documented from different oceanic sites and is accompanied by significant deep water cooling in all oceans. Changes in ocean circulation, deep water formation and ephemeral glaciations have been supposed as driving mechanisms by different authors. Consequently, intensified ventilation of the ^{12}C enriched deep water reservoir and increased rates of terrestrial and marine organic matter oxidation during the sea-level fall caused a reduction in the carbon isotopic composition of the inorganic carbon reservoir. The new δ^{13}C and corresponding δ^{18}O curves from Lägerdorf suggest the negative excursion in the late Campanian to be a precursor that reflect an earlier cooling event and is unidentified in oceanic settings so far.